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Book Review

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Erratum
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ROGER COOKE, EXPERTS IN UNCERTAINTY: OPINION AND SUBJECTIVE PROBABILITY IN SCIENCE. (Oxford University Press 1991) [321 pp.] Index of names, index of subjects, tables. LC 90-22493; ISBN 0-19-506465-8 (cloth $65.00). [200 Madison Ave., New York NY 10016.]

Students of ethics, politics and law have often worried about the quality of the guardianship of society's governmental decisionmakers and scientific experts. As Juvenal put it: "Quis custodiet ipsos custodes?" (Who shall guard the guardians themselves?) Perhaps nowhere is the question of good guardianship more important than in the area of decisionmakers' and experts' use of probabilistic risk assessments, assessments having the power to encourage or discourage the occurrence of future Chernobyls, Bhopals, or Love Canals.

Three of the thorniest guardianship questions in probabilistic risk assessment are the focus of Cooke's excellent volume. What is the proper role of scientific experts who advise policymakers regarding existing and proposed public risks? What is the appropriate behavior of experts, decisionmakers and laypersons in societally risky situations characterized by probabilistic or scientific uncertainty? More specifically, what are the ways in which expert subjective probability assessments can either further or thwart rational consensus about public policy?

Ever since the 1979 Lewis Report — an evaluation of the major probabilistic risk assessment of commercial nuclear fission — officials have recognized and sanctioned the use of experts' subjective probabilities in risk assessments.[1] Yet, some uses of subjective probabilities present obvious and serious threats to the public good and to rational consensus. No one, however, either in the Lewis Report or elsewhere, has systematically and methodically addressed how subjective probabilities ought to be used in estimating and evaluating societal risks. This is the accomplishment of the Cooke volume.

[1] H.W. Lewis et al., *Report to the American Physical Society by the Study Group on Light-Water Reactor Safety*, 47 (1) REVIEWS MOD. PHYSICS 81 (1975); Study Group on Light-Water Reactor Safety, *Nuclear Reactor Safety — the APS Submits its Report*, Physics Today, July 1975, at 38.

Organized into three parts, the first section of EXPERTS IN UNCERTAINTY surveys how risk assessors and policymakers have used expert opinion. The first chapter discusses the Delphi method and scenario analysis, the two main forms in which structured expert opinion was conveyed to decisiomakers during the 1940's, 50's and 60's. The next chapter surveys four important applications of expert opinion: to the aerospace industry, to military intelligence, to the commercial nuclear industry and other objects of probabilistic risk analysis, and to policy analysis. Chapter 3 discusses the emergence, during the 1970's, of expert (artificial intelligence) systems for modeling scientific reasoning under uncertainty.

Chapter 4 summarizes the assets and liabilities of using experts' probabilistic representations of uncertainty. Their chief asset is providing clear criteria for evaluating subjective probability assessments. Their main liability is that, although training in reasoning with uncertainty can be worthwhile, experts typically do not handle subjective probabilities with much skill. Hence, their proffered risk estimates — of everything from a nuclear core melt to the incidence of pesticide-induced cancer — are often highly erroneous. To counter the errors exhibited in experts' opinions, in Chapter 5 Cooke provides some guidelines for employing subjective risk estimates. He argues that we need to develop methodological rules for collecting and evaluating subjective probabilities for things such as technological risks.

In Part II, Cooke assembles the mathematical-modeling tools and proofs that will be needed to provide a more suitable method for avoiding errors in the use of expert opinion. He reviews Savage's normative decision theory (Chapter 6), De Finetti's representation theorem (Chapter 7), techniques for eliciting, scoring, evaluating and weighing various experts' probability assessments (Chapters 8 and 9), and calibrating experts on the basis of their past predictive successes (Chapter 10). Cooke argues that, by using these tools, one can improve rational decisionmaking by quantifying experts' uncertainty as subjective probabilities.

Part III of the volume develops three models (classical, Bayesian and psychological scaling) for combining expert opinions into a probability distribution (Chapters 11–14) and evaluating them. It also surveys the experimental results obtained from the author's using these three models in actual technological, industrial and environmental applications. Each of the applications is employed to quantify and evaluate expert opinion about probabilities associated with risks such as space flight, groundwater transport and chemical-plant failures (Chapter 15).

Cooke's groundbreaking work is of great importance to policymakers, risk assessors and moral philosophers because it "downloads" techniques from probability and statistics onto the problem of evaluating the subjective probabilities of risk assessors. The author skillfully uses mathematical tools to help solve a recurrent problem of politics, law and ethics: how to evaluate the decisions of those who, in a democracy, control science, technology and safety.

Another asset of the volume is its clarity of exposition and its quantitative precision. (The author wisely places more mathematical materials in a 25-page appendix.) Cooke's work displays an impressive encyclopedic knowledge: mathematical, scientific and philosophical sophistication combined with first-hand knowledge of how to evaluate the subjective probabilities used to solve real-world problems. His analysis displays his analytic skills as well as his years of experience in applying his methods to the solution of problems in scientific, technological, industrial and environmental risk assessment.

Cooke is especially to be commended for his noting the shortcomings of his proffered models, for example, the strong modeling assumptions underlying the transformations used in the psychological scaling models.[1] He also is careful to point out possible future research that would improve his models, for example, the need for parametric techniques to elicit subjective probability distributions.[2]

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1 At 271.

2 At 270.

The book is organized well, so that those interested in understanding the policy problems associated with the use of subjective probabilities and quantitative risk assessment can read Parts I and III. However, those who wish merely to use Cooke's models in combining and evaluating expert opinions, or in applying them to real-world problems, can read Parts II and III of the volume. In any case, the book is a "must read" for risk assessors, decision theorists, policymakers, mathematicians, attorneys and environmentalists, as well as moral philosophers.

Although there are no major shortcomings in the book, a few readers may wish that Cooke had spent more time tracing the ethical presuppositions and the policy consequences of the three models that he develops for evaluating expert opinion. Because Cooke has come so far in solving a practical problem of politics, law and ethics, however, perhaps it is just as well that he has left most of the evaluation of his solutions to those who follow after him. He has provided a good first step in freeing us from the subjectivity often associated with subjective probabilities in risk assessment.

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